Section of Orthopædics.

President—Dr. W. T. Gordon Pugh.

DISCUSSION ON THE TREATMENT OF PES CAVUS.

Mr. A. Rocyn Jones.

Pes cavus, or hollow foot, is the name given to a foot with an unusually high longitudinal arch. There is, however, great variation in the relative heights of the arch in quite normal feet, and often a hollow foot of mild degree causes no trouble whatever. A pure cavus deformity is by no means one of the commoner deformities of the foot; it is, however, frequently associated with some other deformity, like varus or equinus, but I shall deal mainly with true or essential cavus.

Ætiology.

The ætiology is often not very clear, chiefly owing to the fact that the disability does not become manifest until long after the exciting cause has disappeared, or has been forgotten. There are, however, distinct contributory causes, and these may be conveniently classified into three main groups, postural, paralytic and traumatic, and subdivided as follows:—

I.—*Postural*: (*a*) Faulty footwear. The wearing of high-heeled short shoes. (*b*) Habit gait. Compensatory for a short limb.

II.—*Paralytic*: (*a*) Acute specific fevers. Paresis, or slight paralysis following rheumatism, scarlet fever, measles, diphtheria, etc. (*b*) Infantile paralysis. (*c*) Chronic nervous disease, e.g., Friedreich's ataxia and progressive muscular atrophy. (*d*) Spinal cord lesions (congenital). Usually associated with skeletal malformations, e.g., spinal bifida occulta and wedge-vertebræ. (*e*) External popliteal nerve injury.

III.—*Traumatic*: (*a*) Foot injury. (*b*) Racial custom, e.g., Chinese foot.

Acute specific fevers and other acute illnesses are perhaps responsible for the majority of hollow feet. Infantile paralysis comes next, but this disease is not so productive of essential cavus as that of a mixed cavus deformity, such as cavo-varus or calcaneo-cavus. Friedreich's ataxia and peroneal muscular atrophy are responsible for some of the most severe types of pes cavus; the convexity of the long arch is often greatly increased. An interesting class is that associated with [1] spinal malformations; some of these have no clinical evidence of spinal abnormality; the defect is only revealed by radiographs. There is undoubtedly an accompanying spinal cord lesion of some kind. The only remaining class that need be mentioned is that due to faulty footwear. This is not so productive of painful hollow feet as would appear. A good number of females wear high-heeled short shoes, yet comparatively few require operative interference for pes cavus.

Mechanism of Pes Cavus.

The maintenance of the long arch of the foot depends primarily upon the tone of the muscles. Those in the sole, including the abductors, short and long flexors of the toes and tibialis posticus increase the height of the arch by approximating the

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toes to the heel; whereas the muscles attached to the dorsum of the foot by opposing each other when pulling upward in front of and behind the ankle, and aided by the downward thrust of the tibia at the summit of the convexity, tend to flatten the arch (see fig. 1). Paralysis of the tendo Achillis will cause the heel

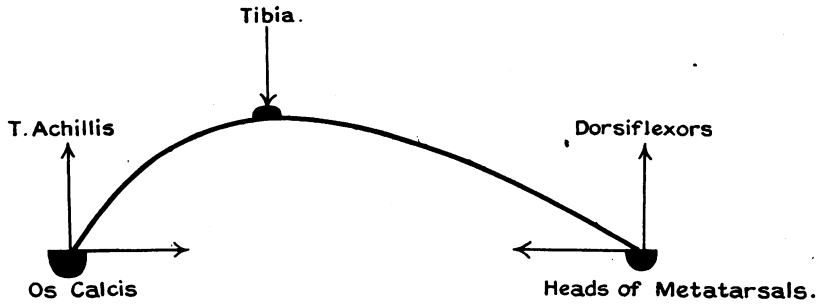

FIG. 1.—Diagram to show the direction of pull of the muscles acting upon the long arch of the foot.

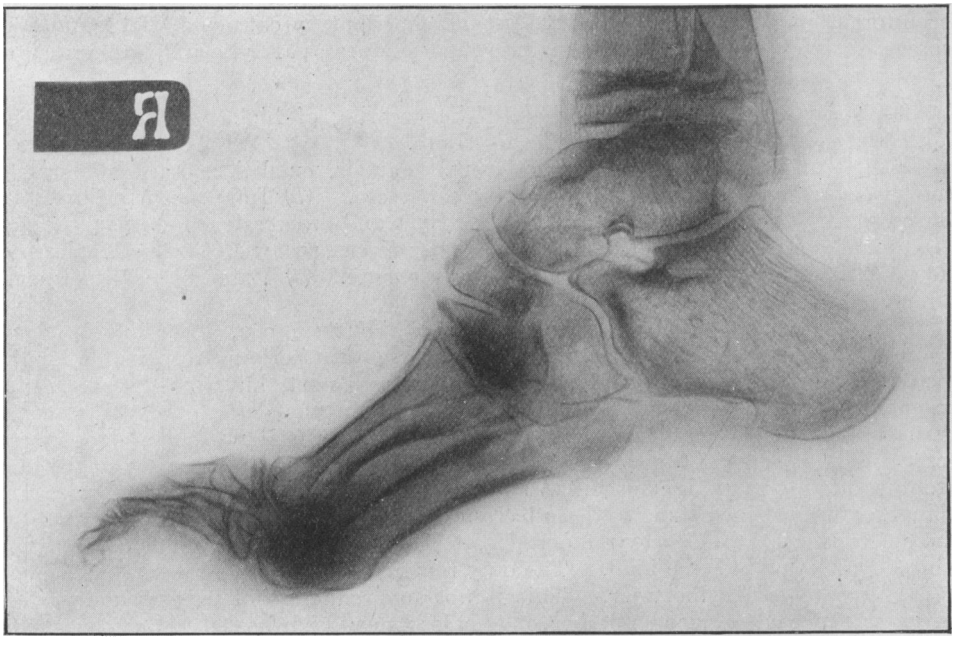

FIG. 2.—Radiograph showing the site of tarsectomy which in this case is limited to the cuneiform bones. The correction clinically was complete. See also fig. 4.

to be drawn towards the toes by the plantar muscles, thus producing a cavus deformity, and the opposing dorsiflexors will tilt the foot upwards, producing a calcaneus heel. When, however, these last muscles are paralysed an equino-cavus deformity is produced.

In the large group of cases following an acute specific fever or other illness, a passing paralysis, or paresis of either the tibialis anticus, or extensor longus digitorum, would explain the development of pes cavus. A little awkwardness in

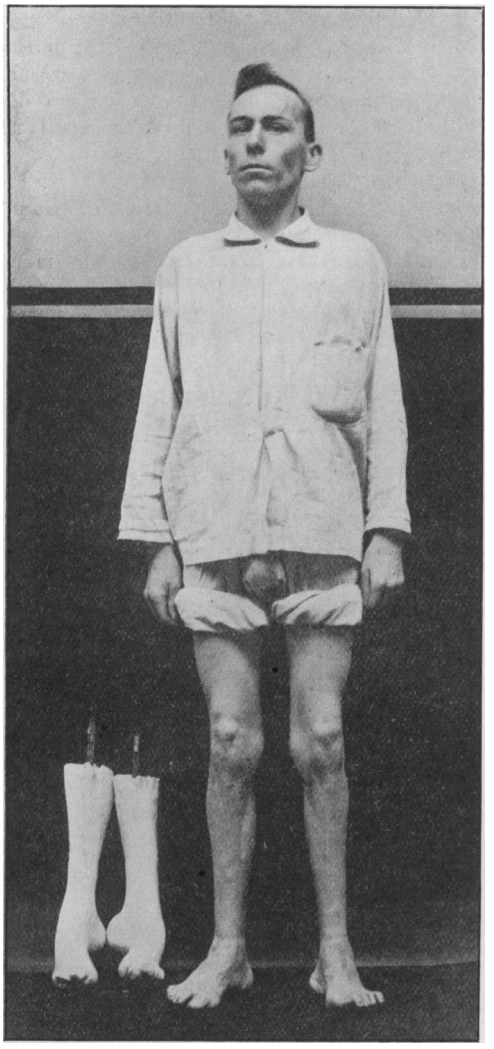

FIG. 3.—G. W. After correction for severe double pes cavus due to progressive muscular atrophy. Casts of his feet before operation are on his right. Tarsectomy was done on the left side only, being the worse foot.

walking, due to slight foot-drop, is sometimes noticed after recovery from the illness and the weakness lasts just long enough to enable the plantar muscles and fascia to shorten. The paralysis disappears and the gait improves, but later, during adoles-

cence, with quickened growth of the foot, the contracted plantar fascia acts like a taut tie-band, pulling the pillars of the arch towards each other, and impeding its expansion antero-posteriorly; the convexity of the arch is thus increased and pes cavus is produced with pain on walking.

Another explanation of these cases is that put forward by Duchenne on the analogy of "main en griffe" produced by ulnar paralysis. He attributed pes cavus and the associated clawing of the toes to paralysis of the interossei and lumbrical muscles, thus allowing the long and short extensors of the toes to overact by hyperextending the first phalanges and flexing the two distal phalanges. The metatarsal heads are depressed, the arch is foreshortened and the plantar fascia contracts.

Recently another suggestion has been made by C. A. Parker [2], of Chicago, who believes that the deformity is due to a perversion of the normal reciprocal action between the flexors and extensors of the toes.

In the frankly paralytic case the same mechanism is at work, but here the paralysis persists, allowing the plantar muscles and fascia to contract even more, with resulting grosser structural changes.

Clinical Types.

Regarded clinically pes cavus may assume any degree of severity, from that of a foot showing little structural alteration to that of one presenting a gross bony deformity. But speaking broadly there are two main clinical varieties and these were separated many years ago by F. R. Fisher [3], one being called *talipes arcuatus*, the other *talipes plantaris*. The former is that type of cavus in which the heel and ball of the foot are in the same horizontal plane; but if the ball assumes a lower level than the heel then the condition is called talipes plantaris. This distinction is best brought out by passively dorsiflexing the foot. It is a useful working classification, for by the use of these terms the precise type of foot we are dealing with is readily conveyed without further description. Talipes arcuatus stands for the less severe degrees of pes cavus, whereas talipes plantaris represents a further developed stage of the deformity with greater retraction of the toes and the typical claw-foot. But although the anterior part of the foot may be dropped considerably and an appearance of talipes equinus simulated, yet there is often little or no shortening of the tendo Achillis.

The patient suffering from pes cavus usually seeks advice because of continued fatigue or actual pain in the feet when walking. This is due to the limited treading surface of the sole and to excessive pressure on the heads of the metatarsals; the frequent presence of callosities at the ball of the foot bear witness to this undue metatarsal thrust.

Treatment.

(1) *Pes Cavus of Slight Degree.*

In cases of slight pes cavus and a tendency to contraction of the toes the mother is taught to manipulate the toes and encourage the child to flex and extend them. At night a rectangular slotted metal splint is worn, with tapes binding the toes to it. The boots must be sufficiently long and roomy enough to allow proper play for the toes. Rarely is any cutting required; at most a simple tenotomy of the plantar fascia and stretching the sole is all that need be done.

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(2) *Pes Cavus of Moderate Degree.*

With older children and those approaching adolescence, it may be enough to teach them toe-flexion and extension exercises and increase the treading surface of the foot by prescribing a modified shoe in which a steel arch is introduced extending

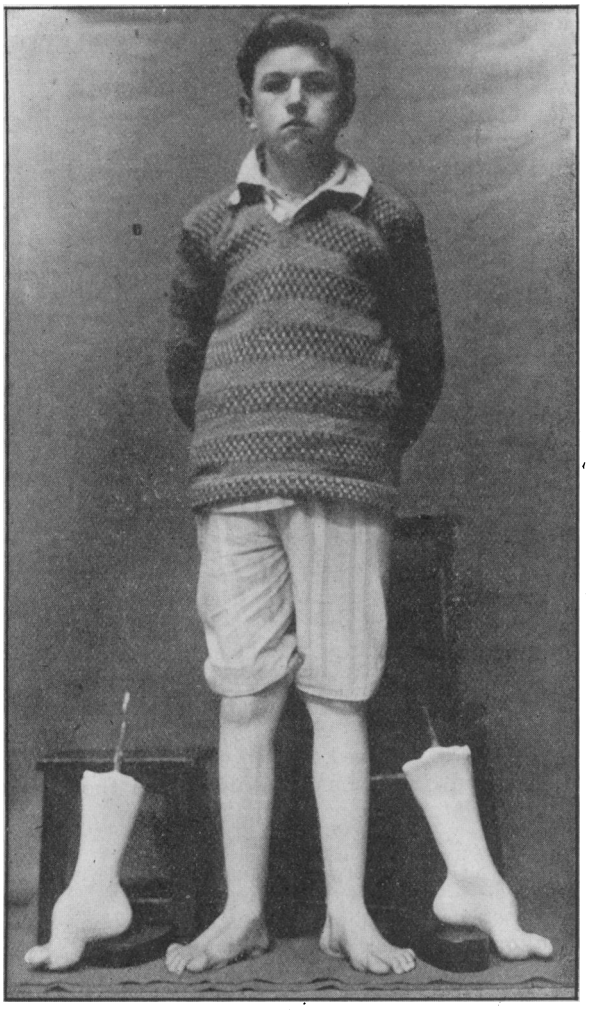

FIG. 4.—C. D., after operation, showing feet corrected; casts of his feet before operation are beside him. Tarsectomy was performed on the right side, Steindler's operation only on the left. The radiograph of his right foot after operation is seen in fig. 2. There was no evidence of nervous disease present.

along its waist from heel to tread; a low plate with a lift behind the metatarsal heads, introduced into an ordinary boot, sometimes takes the place of the special shoe. If painful metatarsal callosities are present a transverse leather bar is added

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to the sole of the boot behind the position of the corns. If these procedures do not give sufficient relief because of the structural changes present, or if it is felt from the outset that palliative measures would be of doubtful value, an attempt is then made to flatten the arch by operation. Formerly I tried to do this either by means of osteoclasis, simple tenotomy of the plantar fascia with wrenching, or excision of the plantar fascia, but these methods have all been replaced by the Steindler operation. I began doing this method by means of a horse-shoe incision around the heel, as suggested in [4] Steindler's first paper. This gave an excellent exposure but there were two serious drawbacks; one, an occasional sloughing of the wound edges, and the other, a delay in the after-treatment; the sole could not be stretched for some time for fear of tearing open the newly-healed wound. Steindler himself gave up the horse-shoe incision and now operates through an incision on the inner side of the foot, extending from the back of the heel to a point in front of the anterior end of the os calcis. I find this route gives good access to the attachment of the plantar fascia, but the ultimate exposure is not as good as that through the old incision. By retracting the edges of the wound the fascia can be easily exposed from the inner side, although the removal of obtruding fat helps considerably. The knife cuts right across the fascia on to the os calcis, the tendinous band is then stripped forward by a curved rougine, taking with it its associated muscles. The long plantar ligament is then exposed. It is very adherent to the bone and may be a little difficult to lift and incise. This having been done, the foot is then wrenched and the arch flattened; the toes are manipulated, the wounds closed and dressings applied. The foot is then encased in plaster of Paris with a slotted sole-plate incorporated. The next day chamois leather tapes are applied, binding the toes; and each day afterwards the tapes are slackened to allow the toes to be stretched, and the tapes are re-applied. Stitches are removed in fourteen days, and then daily massage and stretchings of the fascia and toes take place; a slotted sole-plate is worn in the interval. The patient commences to walk in a soft shoe three weeks after operation. The intrinsic muscles of the foot are electrically treated by means of the faradic foot-bath, and the patient is also taught toe exercises.

In a little while the state of the feet is sufficiently improved to enable the patient to wear ordinary shoes, to the soles of which an outside wedge is added. He is encouraged to continue the exercises and wear the sole-plates at night for several months.

If, when the stitches are removed, the toes are still contracted, the extensor tendons are tenotomized and continuous treatment with the sole-plate is prolonged for three weeks or more before exercises begin.

(3) *Pes Cavus of Severe Degree.*

For the type of pes cavus which constitutes a gross bony deformity, and where every step is a painful one, an attack on the soft parts alone is unlikely to bring relief. In all such cases the Steindler operation should first be performed, to be followed later by a bone resection. I prefer a cuneiform *tarsectomy* at the maximum point of the convexity of the arch, which is usually in front of the astragalus (see fig. 2). A linear incision is made in the middle of the dorsum of the foot; the extensor tendons are drawn aside and a carefully planned wedge extending right across is removed. This is done without respect to the bones traversed, but I find that the cuneiform bones and scaphoid suffer most, although it is surprising what a small wedge will suffice for the purpose. It is important at the outset to aim at the removal of as little bone as possible, for a larger wedge than is necessary will not only flatten the arch,

but produce a bad calcaneus deformity as well. The following case is an example of a severe pes cavus in which this operation was performed :—

G. W. (see fig. 3), aged 23, admitted to hospital with severe double pes cavus. The state of the feet began to trouble him at the age of 6, and it has become gradually worse. Two uncles and one cousin have similar feet. Dr. Feiling diagnosed progressive muscular atrophy. On March 5, 1925, a Steindler operation was performed on the left foot, followed on April 16 by a cuneiform tarsectomy. The foot was encased in plaster until June 30, when a boot was applied. On September 17, 1925, a Steindler and wrenching operation was performed on the other foot, which, however, was not quite so badly deformed as the right one. And although not as flat as its fellow, the improvement was such that no tarsectomy was done, but exercises, massage and electrical treatment were given. He left the hospital on December 1, 1925, wearing boots with varus wedges and provided with sole-plates for night wear. He was last examined on February 22, 1927, and the correction is maintained. Before the operations he was unable to walk at all bare-footed, and had to give up work because of pain in his feet. He is now comfortable, and on his feet all day, being employed as a manual labourer.

Osteotomy.

Where the bony deformity is not very severe, and yet there is a good deal of dropping of the head of the first metatarsal, much improvement can be effected by a method shown to me by Mr. Tubby. A few weeks after the sole has been stretched by Steindler's operation, an osteotomy of the first metatarsal is performed at the junction of the anterior third and posterior two-thirds. The corrected foot is encased in plaster for six weeks and then treated with massage, exercises, etc.

Tendon Transference.

In combination with a plantar fascia operation, one has sometimes cut the extensor longus hallucis and re-attached it to the first metatarsal through a tunnel just behind the head and joined the distal end to the extensor brevis hallucis.

It must be admitted, however, that the result is often disappointing, the new attachment of the tendon exercising very little influence in counteracting the dropping of the anterior part of the foot, and the interphalangeal joint of the great toe becoming, if possible, more flexed.

I have also combined this with the attachment of the extensor of the little toe to the fifth metatarsal, but the result is not impressive. I have no experience of attaching all the long extensors to their respective metatarsals; it is probably a tedious procedure, but if effective would be worth the trouble; American surgeons (Sherman and Ryerson) speak well of it.

Arthrodesis.

In essential cavus there is little scope for arthrodesis. There is one condition, however, in which it is most effective, and that is flexion of the great toe with a painful dorsal corn. The joint is approached through a dorsal longitudinal incision, the tendon is split in its length, and each half retracted. The ends of the bones are removed preferably by an osteotome; a bone forceps is apt to crush and diminish the surfaces of contact. The terminal phalanx is put up slightly hyperextended, and a narrow metal splint, coming well on to the sole, is applied for from four to six weeks.

In the mixed deformity, such as cavo-varus, which is apt to occur in infantile paralysis, an arthrodesing operation, after correction, is valuable in securing stability.

For this condition I have often performed Hoke's triple arthrodesis with a transference of the tibialis anticus to the cuboid to counteract inversion, and the result is usually very satisfactory. Where, however, the paralysis is so severe that both the tibialis anticus and the extensor longus digitorum are affected, so that there is little or no power in dorsiflexing at all, the dropping of the anterior part of the foot presents a difficult problem, for it is apt to persist or recur in spite of a fascia-sliding operation and arthrodesis, although it may not be much in evidence when the patient stands. This type of pes cavus is to my mind the most difficult we are called upon to treat. In a review of my cases made recently the results in this type of case were found to be the least favourable.

But putting these severely-paralysed cases aside, it may be said that the after-results of treatment on the lines indicated for pes cavus is on the whole distinctly satisfactory, both from the point of view of the appearance of the foot, the improvement in walking, and the comfort of the patient.

Conclusions.

(1) A pure cavus deformity is not very common; but associated with other deformities it occurs very frequently.

(2) The ætiology is often obscure. The contributory causes may be divided into postural, paralytic and traumatic. The great majority of cases are paralytic or paretic.

(3) Symptoms usually develop during adolescence, although the exciting cause may be some remote illness.

(4) There is dropping of the foot due to weakness or paralysis, with resulting secondary contracture of the plantar fascia forcing the bony arch to expand upwards during growth.

(5) There are two clinical types: talipes arcuatus and talipes plantaris.

(6) The form of treatment depends upon the degree of cavus. In slight cases, proper boots, splinting and exercises are enough. In more severe types, Steindler's operation and wrenching are performed. This operation is the most important recent advance in the treatment of pes cavus. In very severe cases a fascia-sliding operation and a cuneiform tarsectomy are necessary.

(7) Proper after-care, in the way of splinting, exercises, electrical treatment, and footwear, is important.

References.

[1] Duncker, F., "Pes Cavus and Similar Progressive Deformities as a Result of Spina Bifida Occulta," *Zeit. für Orth. Chir.*, 1913, Bd. xxxiii, Heft 1-2. [2] Parker, C. A., "Hollow Foot—Pes Cavus," *Trans. Section on Orthop. Surg. Amer. Med. Assoc.*, 1913, p. 147. [3] Fisher, F. R., "On Paralytic Deformity of the Foot," *Lancet*, 1889, i, pp. 112, 142, 214. [4] Steindler, A., (1) "Operative Treatment of Pes Cavus," *Surg. Gyn. and Obst.*, May, 1917, p. 612; (2) "The Treatment of Pes Cavus," *Arch. of Surg.*, 1921, March, p. 325.

Dr. Gordon Pugh (President)

said that in connexion with ætiology, Mr. Rocyn Jones mentioned particularly the mild pes cavus which was apt to follow an acute illness; that, he (the President) thought, was not sufficiently appreciated. Often he found that children who had been kept in bed for a long time on account of some disease suffered from mild pes cavus. Every child who had to keep its bed longer than a few days should have the weight of the bed-clothes taken off the feet by means of a low cradle, one only

just high enough for that purpose. Also, such children should perform ankle-joint and foot exercises several times daily. Those measures were very effective in preventing definite, though mild, pes cavus in children who had been kept in bed for some time.

Mr. NAUGHTON DUNN

said that there were several types of pes cavus in which it was possible to say definitely what was the cause of the deformity. These were the cases as to which the line of treatment was generally agreed upon, and it was usually very effective.

The cause might be postural, in that the malposition had begun to occur during an illness, when the cavus deformity might or might not be accompanied by some shortening of the tendo Achillis. Another type of case in which the cause of the deformity was easily explained occurred when the dorsiflexors of the ankle, i.e., the tibialis anticus and peroneus brevis muscle, were weak. Dorsal dislocation of the toes was the result of the effort of the extensors of the toes to clear the foot from the ground in walking. This was followed by dropping of the fore-part of the foot, dorsal dislocation of the toes, with secondary contracture of the plantar structures.

Deformity in these types of pes cavus could usually be completely corrected by division of the plantar fascia and the structures attached to the os calcis, either by the tenotomy knife, or by the open operation suggested by Steindler. The important point in the operation was to bring about complete over-correction of the deformity by means of a wrench. Over-correction of the deformity was necessary so as to enable us to fix the foot in the normal position in plaster without risk of the formation of pressure sores.

If true shortening of the tendo Achillis was also present this structure might be elongated, but only sufficiently to allow the foot being brought to a right angle. If more were done in that way there was a risk of calcaneus deformity following later.

The deformity having been corrected, if there was muscle weakness in the anterior tibial group, tendon transplantation might be helpful. If the toe extensors were active, altering their insertion to the heads of the metatarsal bones would often be effective. In other cases in which there was general laxity of the joints of the foot, with practically no power in the anterior tibial group of muscles, it was sometimes better to resect the mid-tarsal joint so as to prevent recurrence of the deformity, and allow the fore-part of the foot to clear the ground in walking.

Another type of cavus deformity was that associated with calcaneus. This was usually most marked when the tendo Achillis was paralysed, while the posterior tibial and peroneal muscles retained their power. The deformity occurred because these tendons, passing behind the ankle and the fore-part of the foot, in their effort to raise the heel, merely drew the pillars of the arch together and produced a progressive cavus deformity of the sole. In these cases operation on bone was necessary to correct the deformity, and it was also wise to re-inforce the paralysed tendo Achillis by tendon transplantation. A slide was shown illustrating the operation which he practised in those cases.

The type of cavus deformity in which he found operation most difficult was that in which the onset was insidious, progressive, and associated with inversion of the os calcis. By division of the plantar fascia and the structures attached to the os calcis good correction could be secured by thorough wrenching, but there was a great tendency to relapse in these cases.

In the early cases he had found it an advantage to divide the tibialis posticus

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tendon with a view to preventing recurrence of inversion of the os calcis which was often the most troublesome part of the deformity. In more established cases division of the internal lateral ligament and of the strong ligaments between the os calcis and the astragalus might be necessary. If the articular facets were so altered that a good weight-bearing position could not be maintained, arthrodesis of this joint might be necessary.

Mr. Robert Ollerenshaw.

I do not propose to refer to talipes calcaneo-cavus or other compound variety of cavus. Although we are met to consider treatment only, I nevertheless briefly discuss the ætiology of pes cavus, as a proper appreciation of the cause is so important in arriving at the correct line of treatment. I think we all agree that, with extremely

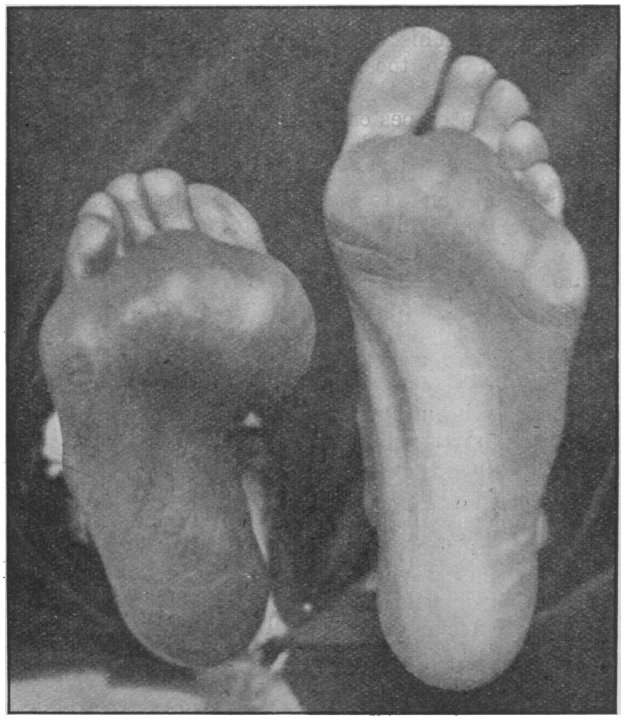

Fig. 5.

few exceptions, pes cavus is due to a disturbance of the normal muscular balance between the extensors and flexors of the ankle and toes. Whether we accept Duchenne's theory, or the suggestion that the over-pull of the extensors of the toes is an attempt to compensate for a deficiency in the normal dorsi-flexors of the ankle, matters nothing, we all observe that the cavus is produced by the over-action of the long extensors of the toes and that, as a result of this, the heads of the

metatarsals and the anterior arch become more and more depressed, and the foot more and more shortened, until a real shortening of the foot occurs. Looking at the sole of such a foot we find the appearance seen in fig. 5. This photograph was taken immediately before operation; the darker colour of the cavoid, right foot, is due to iodine preparation having been applied. Since 1921 I have dealt with such cases entirely by transplantation of the five long extensor tendons. These are passed through a tunnel drilled from side to side through each metatarsal neck, and the tendon sewn back to itself, forming a loop. The interphalangeal joint of the hallux is always arthrodesed to prevent flexion, with its associated pressure troubles. This arthrodesis is not necessary in the other toes because in these the extensor brevis, by

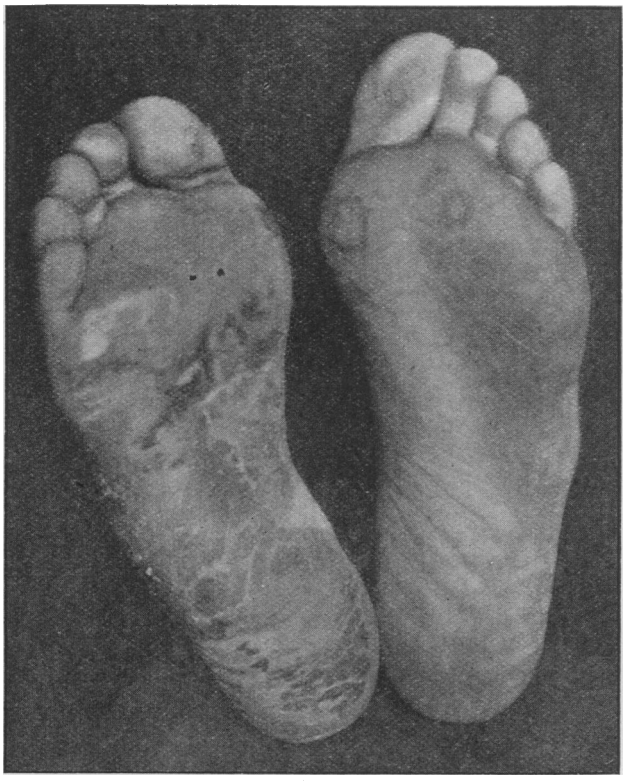

FIG. 6.

its insertion into the dorsal expansion, prevents flexion. In all cases the plantar fascia is divided, but no deeper structures in the sole are interfered with. A toe splint is fixed to the hallux and a metal shoe keeps the foot at rest at a right angle for six weeks. The effect of this transplant is excellent. The transverse arch is raised and the foot is, in consequence, lengthened. Fig. 6 shows the same foot as fig. 5, two months after operation. The appearance is very striking and the improved function is just as impressive. This is by no means an exceptional, but merely a good average result. I have performed this operation thirty-three times in the past five years. The operation has been criticized as being tedious, and I agree that it takes

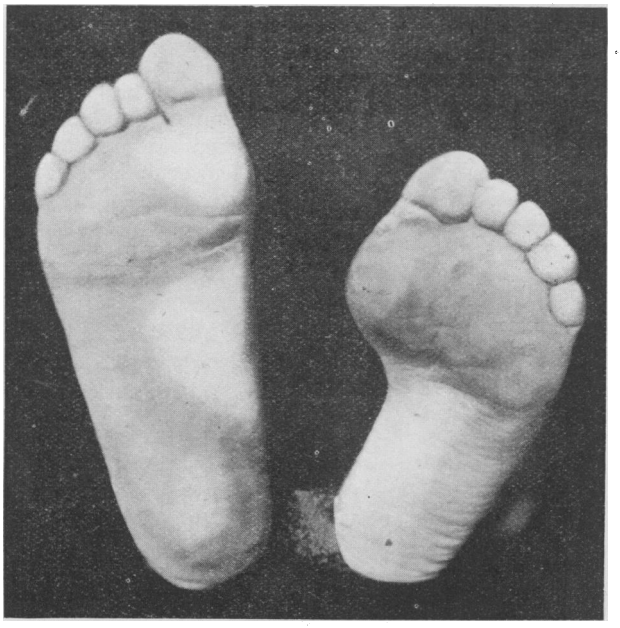

FIG. 7.

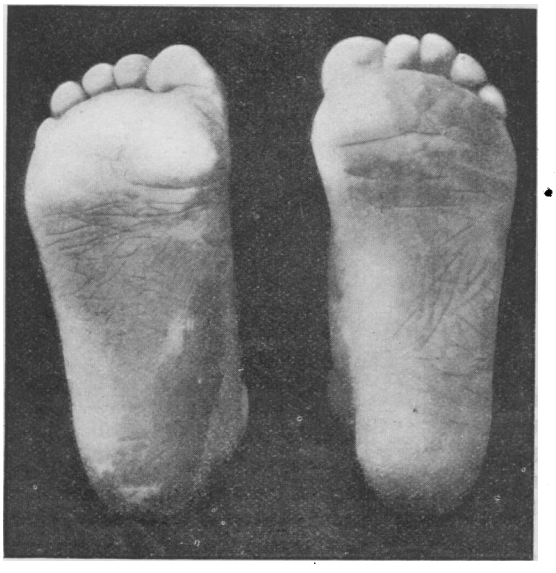

FIG. 8.

about an hour to complete. In my opinion, however, the results so far surpass those obtained by any other method, that such an objection should not be considered. (Figs. 7 and 8 show another case before operation and two months later.)

In the whole of my series of cases I have not had one patient who has not been very gratified with the result of the operation, and many of the patients are working well at regular standing occupations. The patient whose feet are shown in figs. 5 and 6 has worked for a year as a sorter at the General Post Office without the slightest trouble. I certainly consider tendon transplantation to be the operation of choice in pes cavus.

Mr. Whitchurch Howell

said that there were four points he wished to discuss.

(1) *Division of the Plantar Fascia.*—This should be done less and less, and only in the mild cases if a metatarsal bar were not sufficient. Such a case was one in which a boy played football well one season, but the following season he found he was tripping. It was then found that there was a slight contraction of the plantar fascia. In a case of this kind division of the fascia with Jones's tenotome, and manipulation with a wrench, keeping the patient in a walking plaster for six weeks, and the use of a metatarsal bar afterwards, would be sufficient.

(2) *Transference of the Extensor Longus Pollicis through the neck of the Metatarsal Bone should be condemned.* He regarded it as anatomically unsound.

(3) *The Use of a Modified Steindler's Incision.*—He had been employing this for the past five years; instead of making the original horse-shoe incision, he made two incisions, one on each side of the os calcis, so that in the case of a child of 10 to 12 years of age about three stitches were put in afterwards. One thus saved the heel-flap, and every structure it was the surgeon's wish to divide he could see; division was done with the knife, not with the raspatory. In that way one could see that one obtained a gap of half an inch, in certain cases of pes cavus. It was completed with a Thomas's wrench. No Steindler's operation was performed unless a lateral view was taken of both feet; the reason being that the difficult cases of pes cavus were those which were just short of requiring the bone operation. By a side-view skiagram of both feet one could see the relation of the longitudinal arch of the foot in comparison with the base.

(4) *A Steindler and a bony operation* should not be performed on one and the same case. Only one or the other operation should be carried out. The after-treatment consisted in the application of a walking plaster with felt across the dorsum of the toes for three weeks, the stitches being taken out on the tenth day. The patient was allowed to walk in plaster on the fourteenth day. At the end of the third week the plaster was removed, and a felt metatarsal bar was put into a stout leather-soled shoe or boot. At the end of the sixth week the patient was allowed to walk in boots made to measure, with a concealed metatarsal bar, and, if necessary, a varus wedge.

Mr. H. A. T. Fairbank

said there were only two matters to which he wished to refer. One had reference to the Steindler operation or rather a modification of it. For some years, he (the speaker) in the treatment of a foot with severe congenital or other form of cavus, had been in the habit of making an incision on the inner side of the foot in order to divide the ligaments which the Steindler operation did not enable one to reach; then of making another incision on the inner side of the heel, so as to divide the

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structures more or less after the Steindler method. He believed it was Mr. Trethowan who had communicated this idea to him. It was not advisable to divide the ligaments between the internal cneeiform and the first metatarsal, because if that were done subluxation of the base of the metatarsal into the sole might occur. He left that joint untouched. But division of the strong ligaments of the astragalo-navicular and navicular-cuneiform joints was of great use in enabling one to carry out correction in a bad case.

It was doubtful whether, in performing the Steindler operation, one should pare off the structures in the sole from the os calcis deep to or superficial to the periosteum. He had seen some serious lumps of bone in the sole after the Steindler operation. Dr. Steindler's assistant, Dr. Klein, was in this country last week, and he (the speaker) asked him what Dr. Steindler did. The answer was, a subperiosteal operation, but not at the tuberosities of the os calcis; he cut just superficial to the periosteum over the front of the tuberosities, and as soon as he had cleared these, the rest of the separation was done subperiosteally. If performed in this way, no uncomfortable mass of bone developed in the sole.

The only other question to which he wished to refer was that of doing transplantation of tendons to prevent relapse of the cavus. In a fair number of cases he had done transplantation of the extensor tendons into the heads or necks of the metatarsal bones, and had been rather pleased with the results. If all cases were carefully followed up, probably there would be forthcoming a certain number of good and a certain number of bad results, after every method of correction. He had put the whole five extensor tendons into their respective metatarsals, and had done what he thought was rather better, namely, put the extensor longus hallucis into the first metatarsal, the next two tendons into the second, and the next two into the third. He had also put the first three tendons into the first three metatarsals and simply cut the other two. He was not prepared to say as yet which of these gave the best results. There was, however, something to be said for concentrating on the second and third metatarsals. The transplantation of the extensor longus hallucis was a very useful method of dealing with the cocked big toe. In the worst cases excision of the interphalangeal joint was necessary, but in most cases if one inserted the extensor longus hallucis into the first metatarsal, and the distal cut end of this tendon into the periosteum of the proximal phalanx, the results were good. In the case of younger children he had put the extensor hallucis into the second or third metatarsals when there was some varus present, and he had been fairly pleased with the results.

Mr. P. J. VERRALL

said he had carried out the five-tendon transplantation more than a dozen times, and had been very pleased with the results.

With regard to the Steindler operation, he did it in the way many of his colleagues did, making an incision of about an inch on the inner side and, using the knife, cutting down on the bone above the tuberosities of the os calcis; he again used the knife to separate the lower part of the heel from the sole; he then employed

the periosteal elevator above the incision, so producing exactly the result Mr. Fairbank mentioned. It was really doing a subperiosteal separation above the point of the incision.

He was very disappointed with the single first metatarsal transplant. In certain cases, such as those to which Mr. Fairbank had alluded, in which there was a drop of the first metatarsal head and not much else, it was rather promising; but, on the whole, he was not pleased with it. The five-tendon transplantation, though tedious, was one of the most satisfactory of all the operations, combined with the Steindler operation at the same time.

He belonged to a school which refrained from bone operations, except in the rarest kind of cases, for any form of pes cavus. One could divide tendons and ligaments, by wrenching and over-correction, and with a Jones' wrench the sole could be made to bulge down. He very much disliked bone operations.

He was interested in hearing that Mr. Naughton Dunn did his own valuable operation in cases of pes cavus; it seemed to be a very useful proceeding where a bone operation was inevitable.

Mr. Rocyn Jones (in reply)

said he was very gratified by the discussion which had taken place. He agreed that it was important to prevent the development of pes cavus in the way indicated by the President.

He probably had not made his meaning clear with regard to the elongation of the tendo Achillis. He kept the plaster on six weeks instead of three weeks, so as to keep the part for that length of time without functioning.

With regard to bone operations, it was true that these were seldom required. In only four cases of his series had the need arisen for a bone operation. In one or those cases which he had depicted on the screen, he did not see how the condition could have been overcome except by a drastic operation, either a bone operation of one like Mr. Dunn's.

Mr. Dunn had mentioned inversion of the heel. In severe cases that was a bugbear. He had excised the internal lateral ligament and wrenched the foot, everting the heel.

Mr. Whitchurch Howell had mentioned that it was unnecessary to do a bone operation. But there were some cases in which that was imperative; the amount of bone removed, however, was very small. He thought it was better to start off with the Steindler operation for the reason that even after the bone operation had been done the foot could not be flattened, owing to the violent pull on the pillars of the arch by the powerful plantar fascia.

He was very glad to hear Mr. Ollerenshaw mention his tendon transference operation. It was a tedious procedure, and that was probably the reason why it had not been more extensively adopted. American surgeons and some surgeons in this country seemed to have a high opinion of it, because it prevented the dropping of the anterior part of the foot, which was so important.

With regard to Mr. Fairbank's remarks, he (the speaker) had recently had the opportunity of examining a cavus foot which had been amputated because of long-

standing poliomyelitis ; the patient had perforating ulcers with extensive dermatitis, and it had been necessary to perform a Syme's amputation. The layers of small muscles in the sole were adherent to each other and it was difficult to separate the musculus accessorius from the long plantar ligament.

In the Steindler operation, after incising the plantar fascia the rougine swept the muscles forward *en masse*. With adults it was very difficult to cut the periosteum and push it forward, as Steindler suggested in his paper published in 1917. It could be done in the case of children, but not for adults without risk of tearing up bone as well. It was that which caused the post-operative exostoses observed by some American writers. He agreed with Mr. Verrall that the operation could be done without attempting to push the periosteum forward.